

## **PCB exposure through eel consumption in sport fishers as compared to the general population: a probabilistic approach**

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### **Introduction**

Eel (*Anguilla anguilla* L.), a commonly consumed fish, is known to bioaccumulate lipophilic contaminants such as polychlorinated biphenyls (PCBs) and organochlorine pesticides. Since 1994, the Flemish eel pollutant monitoring network monitors about 300 different sites in Flanders (the northern part of Belgium). This includes rivers, canals, polder waters and closed water bodies.

The concentrations of the sum of the 7 indicator PCBs (PCB congeners 28, 52, 101, 118, 138, 153, 180) measured by this monitoring network, are very high: in 80% of all sampled localities, the Belgian PCB standard for fish (75 ng/g fresh weight) is exceeded.<sup>1,2</sup> Therefore, in 2002, the Flemish authorities have issued a catch-and-release obligation for all fish in the 5 most polluted waters in Flanders and an overall catch-and-release obligation for eel in Flanders. In spite of this restriction, some sport fishers still take their eel home for consumption.

The objective of this study was to assess the intake of the 7 indicator PCBs (iPCBs) in this subgroup and to compare their intake with the exposure of a Flemish background population.

### **Materials and Methods**

In order to estimate the exposure to the sum of the 7 iPCBs through the intake of eel, two models were used: for the subpopulation of the sport fishers (and their family), a simple distribution approach was used in which a point estimate for consumption was combined with a full distribution for contamination;<sup>3</sup> for the background population two distributions were combined in a full probabilistic model (using @Risk<sup>®</sup> 4.5 for Excel<sup>®</sup>, Palisade Corporation, Ivybridge, Devon).

#### *Sport fishers*

In 2003, 61,245 individuals in Flanders had a fishing license for public waters. A total number of 3,001 of these licensed sport fishers (out of 9,492 contacted) completed a questionnaire about sport fishing, in which some questions dealt with taking their catch home.<sup>4</sup> Respectively 1.9 % and 5.3 % of these sport fishers indicated that they “always” (group A) or “sometimes” (group B) take home the eel they have caught. No information was obtained about what these fish were used for.

Therefore, some assumptions had to be made concerning the consumption of self-caught eel. Based on the number of fishing occasions, the number of eels caught per occasion and a mean weight of edible portion per eel (150 g), it has been calculated that individuals in group A take home on average 31.4 kg of edible eel per year. For group B it was calculated to be 4.4 kg per year.

We further considered 2 different scenarios for each group:

- scenario A1: the sport fisher takes home 603 g/week (86.14 g/day) and eats all of it (= the worst case scenario);
- scenario A2: the sport fisher takes home 603 g/week and eats half of it;
- scenario B1: the sport fisher takes home 85 g/week (12.14 g/day) and eats all of it;
- scenario B2: the sport fisher takes home 85 g/week and eats half of it.

Data on the PCB contamination of eel in the Flemish water bodies, were based on the eel pollutant monitoring network in Flanders, 1994-2001.<sup>1,2</sup> A distribution was fit on these data, using BestFit<sup>®</sup>-software (Bestfit Probability Distribution Fitting for Windows; Palisade Corporation, Ivybridge, Devon). A loglogistic distribution ( $\gamma$ : 0;  $\beta$ : 731.7;  $\alpha$ : 2.0692) was used. In order to preclude too high contamination data, this distribution was truncated at the upper level (at 14,000 ng PCBs/g eel; i.e. twice the maximum value found during monitoring). A mean bodyweight (bw) of 70 kg for sport fishers was assumed.

#### *The background population*

For the background population, the most recent data on eel consumption, available in Belgium, were used. The daily consumption was estimated using a Food Frequency Questionnaire, completed by 1,179 women of childbearing age, participating in a large Flemish biomonitoring study in the field of environmental health. The data were collected between September 2002 and December 2003.

A total of 132 women (11.2 %) consumed eel at least once during the last year. The mean intake among consumers was 2.87 g/day. A lognormal distribution ( $\mu$ : 2.9289;  $\sigma$  1.5813) was fit using BestFit<sup>®</sup>-software. This distribution was truncated at 15 g/day (2 times the maximal consumption).

For this population, contamination data on the sum of the 7 iPCBs in eel, commercially available in Flanders, were used.<sup>5</sup> A lognormal distribution ( $\mu$ : 470.14;  $\sigma$ : 1929.1) was fit on the contamination data using BestFit<sup>®</sup>-software. This distribution was also truncated at twice the maximal value reported in the database. The consumption and the contamination distributions were combined using a probabilistic model (@Risk<sup>®</sup>). The population mean self-reported bodyweight of the women was 65 kg.

## **Results and Discussion**

At median level, the estimated intake of the background population (consumers only) is 4.4 ng iPCBs/kg bw/day. The median intake for sport fishers varies between 63.3 ng iPCBs/kg bw/day (scenario B2) and 898.3 ng iPCBs/kg bw/day (scenario A1). At the 90<sup>th</sup> percentile, the estimated intake for the background population (consumers only) is 41.1 ng iPCBs /kg bw/day; while the intake for the sportfishers varies between 181.5 and 2,575.6 ng iPCBs /kg bw/day. The intakes for the sum of the 7 iPCBs (expressed in ng PCBs/kg bw/day) for the background population and the 4 different scenarios are presented in table 1 and figure 1.

Unlike for dioxin-like substances, no international provisional tolerated daily or weekly intake (PTDI, PTWI) has been proposed for iPCBs up to now. During the Belgian PCB-incident of 1999, the Belgian National Health Council proposed a PTDI of 100 ng/kg bw/day for the sum of the 7 iPCBs.<sup>6</sup> It should be noted that this reference value, established in the context of a severe food contamination episode and an economical crisis, remains very uncertain. Nevertheless, in order to compare our estimated intakes with some reference value, this PTDI has been used. It is clear that a detailed hazard analysis leading towards an internationally accepted PTWI is strongly needed.

In the background scenario, less than 5 percent of the consumers exceeds this PTDI. On the other hand, in the worst case scenario, more than 95 percent of the sport fishers exceeds the proposed threshold of 100 ng/kg bw/day.

Table 1: Intake of the sum of the 7 iPCBs, expressed in ng PCBs/kg bw/day, for the different scenarios explained in the text

Percentile	ng iPCBs/kg bw/day				
	Background (consumers only)	Sport fishers scenario A1	Sport fishers scenario A2	Sport fishers scenario B1	Sport fishers scenario B2
0	0.0	9.3	4.1	1.0	0.4
5	0.2	216.7	108.4	30.5	15.3
10	0.4	311.0	155.4	43.8	21.9
15	0.7	388.9	54.8	194.4	27.4
20	1.0	460.0	64.8	230.0	32.4
25	1.3	528.6	74.5	264.3	37.3
50	4.4	898.3	449.2	126.6	63.3
75	14.3	1524.5	214.9	762.3	107.5
80	19.2	1750.0	246.7	875.0	123.3
85	26.7	2067.3	291.4	1033.4	145.7
90	41.1	2575.6	1288.0	363.1	181.5
95	80.2	3655.2	1827.6	515.2	257.8
100	1283.6	17130.9	8455.1	2405.8	1188.8

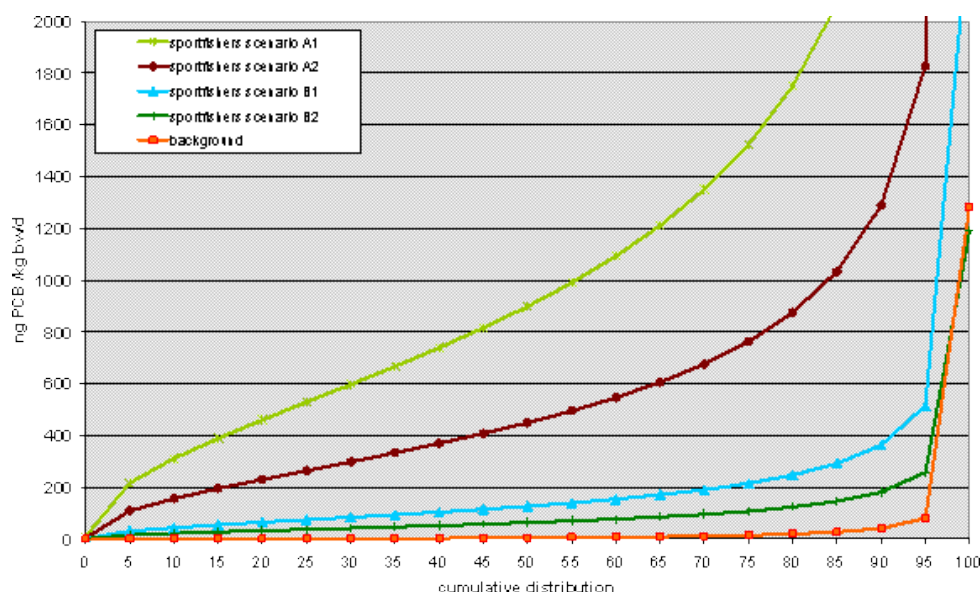


Figure 1: Cumulative distribution function of the intake of the 7 iPCBs for the background population (consumers-only) and for the different scenarios in the subpopulation of sport fishers (consumers-only) (as explained in the text)

It should be noted that the results, presented in this study (figure 1), are based on consumers only. Respectively only 11.2 % of the background population and 7.2 % of the sport fishers consumed eel. When extrapolating our results to an intake assessment of the population at large (consumers and non consumers), the results would be situated at the higher end of the distribution. On the other hand, only the intake via eel is taken into account in this exposure assessment: other food items, especially those containing animal fat, will also contribute to the overall exposure.

Comparable data in literature are scarce. However, a Dutch intake assessment of iPCBs via the whole diet resulted in comparable estimated intake distributions, with a median of 4.8 ng iPCBs/kg bw/day. At the 90<sup>th</sup> percentile 8.6 ng iPCBs/kg bw/day was estimated.<sup>7</sup>

In conclusion, the intake of PCBs via the consumption of self-caught eel seems to be at a level of high concern. Further monitoring seems appropriate. Risk characterisation would be easier if, in analogy with dioxin-like

substances, a reference TDI or TWI could be established for the sum of the 7 iPCBs. The catch-and-release obligation should be maintained and supervised (more) carefully.

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### References

1. Goemans G., Belpaire C., Raemaekers M. and Guns M. (2003) The Flemish eel pollution monitoring network 1994–2001: polychlorine biphenyls, organochlorine pesticides and heavy metals in eel. Institute for Forestry and Game Management, report. IBW.Wb.V.R.2003.99. (in Dutch) 169 p.
2. Goemans G., Belpaire C. (2004) *Organohalogen Compounds* 66: 1834 – 1840.
3. Lambe J. (2002) *Proc Nutr Soc* 61: 11-18.
4. Vandecruys W. (2004) Economical and social aspects of angling in public waters in Flanders (Thesis)(in dutch). Limburgs Universitair Centrum, Diepenbeek, Belgium.
5. PCB measurements in eel for commercial consumption in Flanders. Expert document for the Belgian Health Council, 22th of November 2000. C. Belpaire, G. Van Thuyne and K. Cooreman
6. The issue of tolerated PCB concentrations in food items, Expert document for the Belgian Health Council, 22th of November 2000 [http://www.health.fgov.be/CSH\\_HGR/Nederlands/Advies/Advies\\_PCB\\_in\\_vis\\_11-2000\\_NL.htm](http://www.health.fgov.be/CSH_HGR/Nederlands/Advies/Advies_PCB_in_vis_11-2000_NL.htm) (in Dutch)  
[http://www.health.fgov.be/CSH\\_HGR/Francais/Avis/concentration\\_PCB.html](http://www.health.fgov.be/CSH_HGR/Francais/Avis/concentration_PCB.html) (in French)
7. Baars A. J., Bakker M. I., Baumann R. A., Boon P. E., Freijer J. I., Hoogenboom L. A. P., Hoogerbrugge R., van Klaveren J. D., Liem A. K. D., Traag W. A. and de Vries J. (2004) *Toxicology Letters* 151: 51-61